

University of Nebraska - Lincoln

DigitalCommons@University of Nebraska - Lincoln

Space, Cyber, and Telecommunications Law
Program Faculty Publications

Law, College of

2007

Navigating Safely through the 21st Century: ICAO and the Use of GNSS in Civil Aviation

Frans G. von der Dunk

University of Nebraska - Lincoln, fvonderdunk2@unl.edu

Follow this and additional works at: <https://digitalcommons.unl.edu/spacelaw>



Part of the [Air and Space Law Commons](#)

von der Dunk, Frans G., "Navigating Safely through the 21st Century: ICAO and the Use of GNSS in Civil Aviation" (2007). *Space, Cyber, and Telecommunications Law Program Faculty Publications*. 30.

<https://digitalcommons.unl.edu/spacelaw/30>

This Article is brought to you for free and open access by the Law, College of at DigitalCommons@University of Nebraska - Lincoln. It has been accepted for inclusion in Space, Cyber, and Telecommunications Law Program Faculty Publications by an authorized administrator of DigitalCommons@University of Nebraska - Lincoln.

NAVIGATING SAFELY THROUGH THE 21ST CENTURY: ICAO AND THE USE OF GNSS IN CIVIL AVIATION

FRANS G. VON DER DUNK*

I. INTRODUCTION

December 2005 saw the launch of GIOVE-A, the first Galileo satellite, into orbit.¹ With that event, the entry into outer space of a third satellite navigation system became a fact. Galileo, the European version of a full-fledged Global Navigation Satellite System (GNSS), will have 30 satellites operational in orbits at some 23,000 km altitude by 2010 (according to current planning). It is already being underpinned by an institutional structure based essentially on a Public-Private Partnership, with an European GNSS Supervisory Authority established as of the summer of 2004.² The Russian system GLONASS, operational since 1982 but because of financial problems by now having only 16 of 24 satellites in operation (from a 2001-low of only seven), is bent on restoring the system to full capacity by 2010-1.³ And the US GPS-system, the oldest GNSS operating since 1978, is planning to start the launch of a third-generation of satellites to further enhance performance by 2013.⁴

Though the use of GNSS is by no means limited to civil aviation or even aviation in general,⁵ from the beginning this sector was most interested in the potential benefits that GNSS could bring in view of its focus on the safety and efficiency of operations as well as its overriding international character. Thus, already in 1983 the International Civil Aviation Organisation (ICAO) established

* Director, Space Law Research, International Institute of Air and Space Law, Leiden University. The author has, inter alia, served as Legal Task Manager for a number of GNSS- and Galileo-related projects with the European Commission and the Galileo Joint Undertaking. This Article forms part of the Leiden Faculty of Law research programme "Securing the rule of law in a world of multilevel jurisdiction: coherence, institutional principles and fundamental rights".

1. See e.g. *Inside GNSS*, January/February 2006, pp. 16-17.

2. This was achieved by means of the Council Regulation on the establishment of structures for the management of the European Satellite Radio-navigation Programmes, No. 1321/2004/EC, of 12 July 2004; OJ L 246/1 (2004). The European GNSS Supervisory Authority itself was a successor to the Galileo Joint Undertaking, established by means of Council Regulation setting up the Galileo Joint Undertaking, No. 876/2002/EC, of 21 May 2002; OJ L 138/1 (2002). See further e.g. the author's *Towards Monitoring Galileo: the European GNSS Supervisory Authority in statu nascendi*, in 55 *ZLW* (2006), pp. 100-17.

3. *Inside GNSS*, January/February 2006, pp. 28-9; *Inside GNSS*, March 2006, p. 16.

4. *Inside GNSS*, January/February 2006, pp. 26-7.

5. Currently, the use of GPS signals in for example maritime transport, road taxi applications and leisure applications such as yachting and mountaineering is already rather widespread.

a Committee on Future Air Navigation Systems (FANS)⁶ which *inter alia* was tasked to identify possible benefits, risks and drawbacks of the use of GNSS for aviation purposes, and to come forward with recommendations for dealing with them properly.

Many states were, and continue to be, worried about the ramifications of dependence upon a single system (GPS; GLONASS being only marginally operational) run by military authorities, and hence somewhat hesitant to work on further implementation mechanisms and measures. From the above, however, it is clear now that GNSS is here to stay. GNSS, if implemented correctly, can revolutionise aircraft operations by developing into a global seamless navigation system, allowing enormous safety gains in terms of more comprehensive and accurate information on the positions and movements of aircraft as well as economic gains in that it calls for only one infrastructure in terms of equipment and procedures. GNSS would, under circumstances, even allow for the introduction of 'free routing' and 'free flight' and do away with the rigidity inherent in prescribed 'air lanes', thus allowing still more safety and economic gains.

The importance of these developments has been recognised *inter alia* by expanding the original FANS concept to that of CNS/ATM (Communication, Navigation and Surveillance/Air Traffic Management), and establishing within ICAO a Legal Technical Expert Panel (LTEP) to make sure all relevant legal aspects were considered. Therefore, at this juncture the underlying issues have become a matter of practical urgency: how and in what ways can GNSS enhance the safety as well as the efficiency of international civil aviation?

This raises the fundamental question how the existing legal framework applicable to civil aviation, and especially its safety-related aspects, is currently dealing with, respectively plans to deal with, the use of GNSS in that sector. After all, satellite navigation as an object for legal and regulatory action even within the aviation field presents a relatively new phenomenon, and at present there is relatively little law or regulation that is explicitly and clearly dedicated to it. On the other hand, legal parameters exist in abundance which, though not dedicated to GNSS, do or may exercise an impact, often indirectly, 'by default'. In addition, in aviation some substantial efforts have already resulted from the efforts which kicked off with the establishment of the FANS Committee back in 1983.

The present article maps the legal framework for civil aviation as it is geared to deal with safety issues up to and including GNSS. As there clearly is a key role to play for ICAO in this field, it surveys in particular the role of that organisation as developed at the international level to heed the international character of aviation, its competencies in the areas concerned as well as the results so far of the use of such competencies.

Thus, also, it represents an interesting illustration of how space law in the narrower sense of the word (as based principally on the five United Nations

treaties on outer space⁷) no longer suffices to regulate a space activity with far-reaching consequences down-stream, in this case in civil aviation, and hence has to take crucial elements of (in this case) air law on board in order to allow the maximum benefits GNSS can bring to be reaped in this particular sector.

Most importantly, however, it tries to answer the question: are ICAO and the current framework provided by international air law able to safely – and efficiently – navigate civil aviation through the 21st century?

II. THE SUBSTANCE OF THE CHICAGO CONVENTION

A. The Chicago Convention and Air Navigation

The Convention on International Civil Aviation of 1944, colloquially known as the Chicago Convention,⁸ forms the basis for all safety regulation of international air traffic, also containing a number of provisions crucially relevant to air navigation and the provision of air navigation services.

Part I of the Chicago Convention, entitled “Air Navigation”, effectively provides only for the very general basis of any specific air navigation regulation, such as by confirmation of the absolute sovereignty of a state over its airspace.⁹ The mirror side of this sovereignty, which forms the point of departure for all international harmonising efforts, is the international responsibility for air

6. See e.g. *in extenso* B.D.K. Henaku, *The Law on Global Air Navigation by Satellite: An Analysis of Legal Aspects of the ICAO CNS/ATM System*, 1998.

7. This concerns the following five treaties:

- Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies (hereafter Outer Space Treaty), London/Moscow/Washington, adopted 19 December 1966, opened for signature 27 January 1967, entered into force 10 October 1967; 6 ILM 386 (1967); 18 UST 2410; TIAS 6347; 610 UNTS 205;
- Agreement on the Rescue of Astronauts, the Return of Astronauts and the Return of Objects Launched into Outer Space, London/Moscow/Washington, adopted 19 December 1967, opened for signature 22 April 1968, entered into force 3 December 1968; 19 UST 7570; TIAS 6599; 672 UNTS 119;
- Convention on International Liability for Damage Caused by Space Objects, London/Moscow/Washington, adopted 29 November 1971, opened for signature 29 March 1972, entered into force 1 September 1972; 10 ILM 965 (1971); 24 UST 2389; TIAS 7762; 961 UNTS 187;
- Convention on Registration of Objects Launched into Outer Space, New York, adopted 12 November 1974, opened for signature 14 January 1975, entered into force 15 September 1976; 14 ILM 43 (1975); 28 UST 695; TIAS 8480; 1023 UNTS 15; and
- Agreement Governing the Activities of States on the Moon and Other Celestial Bodies, New York, adopted 5 December 1979, opened for signature 18 December 1979, entered into force 11 July 1984; 18 ILM 1434 (1979); 1363 UNTS 3.

8. Convention on International Civil Aviation (hereafter Chicago Convention), Chicago, done 7 December 1944, entered into force 4 April 1947; 15 UNTS 296; TIAS 1591; Cmd. 6614; UKTS 1953 No. 8; ATS 1957 No. 5; ICAO Doc. 7300.

9. See Art. 1, Chicago Convention; also Art. 2.

navigation safety provided for by Article 28.¹⁰

States exercise their sovereignty also when it comes to regulation and enforcement of air navigation structures, equipment and services within their territories, for example by dictating which part of its airspace may be used by national and foreign aircraft. As one consequence thereof, Article 5 of the Convention establishes the right of a sovereign state to prescribe specific routes in its national airspace for non-scheduled flights for reasons of air navigation.¹¹ With respect to scheduled flights, the sovereign control of a national state over its territory is even more explicit: states can attach almost any conditions to such flights.¹²

If states would stick too rigidly to their rights of sovereign control in their respective national airspaces, international aviation would be stifled fundamentally. In principle, each international flight may then be confronted with completely divergent requirements and conditions for flights, including such requirements and conditions referring to aviation navigation and safety issues. This necessitates at the very least the cooperation of the authorities of different states to facilitate and enhance the safety and efficiency of aviation. Also, any crossing of an inter-state boundary would immediately call for a change of navigation service provider, regardless of practical considerations and actual circumstances, and any potential flexibility would be foreclosed. Moreover, the issue of navigation services in international areas would remain unsolved. It is in particular in those three areas that the Chicago Convention steps in to offer itself a first set of rules trying to serve the needs of international aviation.

B. Navigation in National Airspaces

As to the first issue, of threatening divergence in relevant national provisions, at the level of the Chicago Convention harmonisation efforts resulted in the creation of some international obligations regarding air navigation mitigating any

-
10. Art. 28, Chicago Convention, reads: "Each contracting State undertakes, so far as it may find practicable, to: (a) Provide, in its territory, airports, radio services, meteorological services and other air navigation facilities to facilitate international air navigation, in accordance with the standards and practices recommended or established from time to time, pursuant to this Convention; (b) Adopt and put into operation the appropriate standard systems of communications procedure, codes, markings, signals, lighting and other operational practices and rules which may be recommended or established from time to time, pursuant to this Convention; (c) Collaborate in international measures to secure the publication of aeronautical maps and charts in accordance with standards which may be recommended or established from time to time, pursuant to this Convention".
 11. Art. 5, Chicago Convention, provides: "Each contracting State nevertheless reserves the right, for reasons of safety of flight, to require aircraft desiring to proceed over regions which are inaccessible or without adequate air navigation facilities to follow prescribed routes, or to obtain special permission for such flights".
 12. Art. 6, Chicago Convention, reads: "No scheduled international air service may be operated over or into the territory of a contracting State, except with the special permission or other authorization of that State, and in accordance with the terms of such permission or authorization".

undue rigidity resulting from strict adherence to individual sovereignty over national airspace.

Thus, while a contracting state is free to establish rules for the operation and navigation of aircraft within its territory, these rules shall be applied without discrimination to the aircraft of all states parties to the Chicago Convention.¹³ Moreover, these rules shall be kept uniform, to the greatest extent possible, with those established under the Convention.¹⁴ All air navigation facilities provided for public use must be accessible to all aircraft of the states parties to the Convention without discrimination and under uniform conditions.¹⁵ Thus, for example, charges for their use must be imposed irrespective of the nationality of the aircraft.

Chapter XV of the Convention finally comprises provisions on airports and navigation facilities.¹⁶ It deals with the improvement, financing and maintenance of air navigation facilities required for the safe, regular, efficient and economical operation of international air services. Thus, already the Convention itself lays the groundwork for a first level of harmonisation of national requirements and conditions for the sake of safe and efficient international aviation, which includes at least in principle the use of GNSS for such purposes.

C. Navigation in Other States' National Airspaces

Article 28 of the Chicago Convention only refers to the provision of air navigation facilities by a state on its territory respectively within and for its national airspace. The need for seamless provision of air navigation services around the world, however, also requires occasionally air navigation facilities and services to be provided in airspace over non-national territory, that is to start with over another state's territory. While normally an individual state accepts responsibility to provide services in any part of its airspace, it is not obvious either that, from the other end as it were, it would accept the same responsibility with regard to non-national airspace; for that reason, states would better conclude explicit agreements on this matter – preferably under the auspices of ICAO.

A conceptual alternative would arise once services, for the purpose of responsibility under Article 28 of the Chicago Convention, would come to be defined not geographically (i.e. with respect to the state's airspace they would be provided in) but 'operationally' (i.e. with respect to the state's air navigation service provider actually guiding the aircraft). This might actually have to be realised if full benefits should be reaped from GNSS: most important for any allocation of responsibility should be the issue of who actually provided an aircraft with navigation guidance at any relevant moment. Only at a secondary level

13. See Art. 11, Chicago Convention.

14. See Art. 12, Chicago Convention.

15. See Art. 15, Chicago Convention.

16. See Arts. 69-71, Chicago Convention.

should the responsibility of the state in whose airspace the aircraft was at such a moment come into play, basically for having delegated its sovereign rights to provide air navigation services to another state.

For the time being, however, Article 22 of the Chicago Convention, under the heading of Chapter IV "Measures to Facilitate Air Navigation", at least calls for inter-state agreements, i.e. the adoption of practical measures by states, through the issuance of special regulations or otherwise, to facilitate or expedite navigation by aircraft between the territories of contracting states.¹⁷

Hence, effectively an 'over-flow' zone in the border area between relevant pairs of states may be – and often indeed is, for example in the case of Spain and Portugal – created. In such an area the obligation to maintain air navigation and communication systems and services may extend beyond the territory of contracting states proper, well into the territory of neighbouring states without as such thereby violating the sovereign rights of those other states.

The idea of functional blocks of airspace, which is the fundamental of the Single European Sky (SES)¹⁸ initiative taken by the Commission, already goes a considerable step further beyond the 'traditional' sovereignty of a state over its national airspace. This is particularly important in view of the continuous flow of international air traffic which an effective global CNS/ATM system incorporating GNSS services should ensure. Apparently, states under circumstances can accept that the full use of sovereign rights to provide air navigation services within their own airspaces (or at least part thereof) to the exclusion of others would not automatically require full control over the signals underlying – even if in a crucial manner – such services for the greater common good of seamless air navigation services.

In that respect, the provisions of Article 22 of the Chicago Convention and the ideas behind the Single European Sky may represent an interesting precedent for GNSS, where most states of the world would after all have to accept for their whole respective territory and airspace that some entity outside their legal control (whether this concerns GPS, GLONASS or Galileo) plays a crucial role in the provision of air navigation services by means of provision of GNSS signals.

D. Navigation in International Airspaces

By the very nature of international law and the sovereignty principle, a third area arises where air navigation services are and will have to be provided. This

17. Art. 22, Chicago Convention, reads: "Each contracting State agrees to adopt all practicable measures, through the issuance of special regulations or otherwise, to facilitate and expedite navigation by aircraft between the territories of contracting States, and to prevent unnecessary delays to aircraft, crews, passengers and cargo, especially in the administration of the laws relating to immigration, quarantine, customs and clearance".

18. See e.g. Regulation of the European Parliament and of the Council on the Interoperability of the European Air Traffic Management Network, No. 552/2004/EC, of 10 March 2004; OJ L 96/26 (2004).

concerns international airspace, more precisely, the airspace above international waters and (presumably) Antarctica. Here, no state can act as the territorial sovereign, and no state can consequently *ipso facto* exercise comprehensive sovereign powers regarding air navigation to the exclusion of others.

Here, Article 12 of the Chicago Convention provides that “over the high seas, the rules in force shall be those established under this Convention”. Essentially the power was given to ICAO to charge individual states with the competencies to provide air navigation services to the exclusion of others in well-circumscribed Flight Information Regions (FIR’s) over the high seas. Following from Article 12, Annex 2 to the Chicago Convention on “Rules of the Air” provides further guidance on the issue.

All this, clearly, on behalf of the community of states as a whole and consequently only within the legal parameters provided by the Convention itself and ICAO’s relevant competencies. Again, the major relevance of this mechanism for any GNSS lies in the acceptance by states of, and reliance on, another state providing safety-critical navigation services for their aircraft.

For example, several European states thus bear such responsibilities in the Baltic and Mediterranean seas – and are accepted in doing so by all other states without much further ado. Even more important is the North Atlantic area, divided into a few oceanic FIR’s the responsibility of – as far as Europe is concerned – Iceland, United Kingdom and Portugal, and to a lesser extent Denmark and Norway. In the case of Portugal the provision of GNSS would be of particularly special importance, in view of Portuguese airspace, for 95% being airspace over the high seas, being the second largest airspace in Europe.

E. Concluding Remarks

In sum, the Chicago Convention itself provides a rather general regulatory framework for air navigation services, whether or not including GNSS, in view of the major role navigation plays in the context of the safety of civil aviation and the focus of the Convention on that issue. It does not itself elaborate the substance of any such regime, but provides the foundations for a proper regulatory regime establishing relevant competencies as well as further substance, subject to continuing technical, operational and political developments, as will be discussed in the next chapters.

All the same, already the Convention’s general thrust towards international cooperation in safety matters, even if at the cost of some sovereignty-concerns, has led to a general attitude of states to consider practical and workable rather than sovereignty-obedient solutions, such as those pertaining to the high seas.

III. THE INTERNATIONAL CIVIL AVIATION ORGANISATION AND ITS COMPETENCIES

A. ICAO: General Aspects

As a second major contribution to the harmonisation of international air law

in the field of air navigation for the sake of safety and efficiency, the Chicago Convention established the International Civil Aviation Organisation (ICAO) and endowed it with important legal and regulatory functions in the field.¹⁹ ICAO being a classical intergovernmental organisation, only states can be members of it.²⁰ As a consequence, also such European organisations as Eurocontrol²¹ and the European Aviation Safety Agency (EASA)²², having acquired distinct and central positions and relevant legal status in the field, or even the European Union with its legislative, sometimes supranational, competencies²³, have no role in ICAO beyond that of an observer. The main organs of ICAO are the Assembly and the Council.²⁴

The Assembly is composed of representatives from the member states, each member state being entitled to one vote. Decisions of the Assembly shall be taken by simple majority voting, unless specifically otherwise provided for. Meetings of the Assembly shall be held at least every three years, as convened by the Council; extraordinary meetings of the Assembly may be called for by either the Council or at the joint request of at least ten member states.²⁵

The Council is a permanent body composed of thirty member states, elected from the Assembly in accordance with a complicated system, with elections every three years. Other states may participate in Council meetings, but do not have a vote when it comes to making decisions. Also in the Council voting shall be by simple majority. The Council is headed by a President who serves in a private capacity and shall have no vote.²⁶

A final, subordinate body of ICAO of prime relevance for the present analysis is the Air Navigation Commission (ANC). It is composed of fifteen

19. See Part II, Chicago Convention, comprising Chapters VII-XIII, i.e. Arts. 43-66.

20. Cf. Art. 43, 44(f), 48, 50, 91-93, Chicago Convention.

21. Established by the Convention Relating to Co-operation for the Safety of Air Navigation, Brussels, done 13 December 1960, entered into force 1 March 1963; 523 UNTS 117; Cmd. 2114.

22. Established by means of the Regulation of the European Parliament and of the Council on common rules in the Field of Civil Aviation and Establishing a European Aviation Safety Agency, No. 1592/2002/EC, of 15 July 2002; OJ L 240/1 (2002).

23. The European Union has realised a legal presence e.g. in the field of aviation safety through a number of Directives and Regulations, such as the Council Regulation on the Harmonization of Technical Requirements and Administrative Procedures in the Field of Civil Aviation, (EEC) 3922/91, of 16 December 1991; OJ L 373/4 (1991); the Council Directive on the Definition and Use of Compatible Technical Specifications for the Procurement of Air-traffic-Management Equipment and Systems, 93/65/EEC, of 19 July 1993; OJ L 187/52 (1993); the Commission Directive Adopting Eurocontrol Standards and Amending Council Directive 93/65/EEC on the Definition and Use of Compatible Technical Specifications for the Procurement of Air-traffic-Management Equipment and Systems, 97/15/EC, of 25 March 1997; OJ L 95/16 (1997); and the Commission Regulation Adapting to Scientific and Technical Progress Council Regulation (EEC) No 3922/91 on the Harmonisation of Technical Requirements and Administrative Procedures in the Field of Civil Aviation, No. 2871/2000/EC, of 28 December 2000; OJ L 333/47 (2000).

24. See Art. 43, Chicago Convention.

25. See Art. 48, Chicago Convention.

26. See Arts. 50-53, Chicago Convention.

members, appointed by the ICAO Council from among persons nominated by contracting states with suitable qualifications and experience in the science and practice of aeronautics. The President of the ANC shall be appointed by the Council.²⁷

B. Competencies of the Main ICAO Bodies Relevant for Air Navigation

The main competencies of ICAO in the field under consideration rest with the Assembly and the Council, subsidiary with the Air Navigation Commission.

Article 49 of the Chicago Convention lists the powers and duties of the Assembly, the relevant ones for the present survey being those to:

“c) Examine and take appropriate action on the reports of the Council and decide on any matter referred to it by the Council;

d) Determine its own rules of procedure and establish such subsidiary commissions as it may consider to be necessary or desirable;

(...)

g) Refer, at its discretion, to the Council, to subsidiary commissions, or to any other body any matter within its sphere of action;

h) Delegate to the Council the powers and authority necessary or desirable for the discharge of the duties of the Organization and revoke or modify the delegations of authority at any time;

i) *Carry out the appropriate provisions of Chapter XIII;*²⁸

j) *Consider proposals for the modification or amendment of the provisions of this Convention and, if it approves of the proposals, recommend them to the contracting States in accordance with the provisions of Chapter XXI;*²⁹

k) Deal with any matter within the sphere of action of the Organization not specifically assigned to the Council.”

Thus, the Assembly plays a key role in extending the scope of ICAO activities and/or other activities within the framework of the Chicago Convention to issues of air navigation including the use of satellites for such purposes, as it has broad competencies to take relevant action in a number of ways.

The Council’s general functions have been subdivided into “mandatory functions” and “permissive functions”. As regards the mandatory functions, the Council shall *inter alia*:

27. See Art. 56, Chicago Convention.

28. Chapter XIII, Arts. 64-66, Chicago Convention, refers to other international arrangements such as security arrangements (Art. 64) and the appropriate role for ICAO in that respect.

29. Chapter XXI, Arts. 91-95, Chicago Convention, deals with ratifications, adherence, amendments and denunciations to the Convention which *ipso facto* includes ICAO.

“b) Carry out the directions of the Assembly and discharge the duties and obligations which are laid on it by this Convention;

(...)

e) Establish an Air Navigation Commission, in accordance with the provisions of Chapter X;³⁰

(...)

i) Request, collect, examine and publish information relating to the advancement of air navigation and the operation of international air services, including information about the costs of operation and particulars of subsidies paid to airlines from public funds;

j) Report to contracting States any infraction of this Convention, as well as any failure to carry out recommendations or determinations of the Council;

k) Report to the Assembly any infraction of this Convention where a contracting State has failed to take appropriate action within a reasonable time after notice of the infraction;

l) Adopt, in accordance with the provisions of Chapter VI of this Convention, international standards and recommended practices; for convenience, designate them as Annexes to this Convention; and notify all contracting States of the action taken;³¹

m) Consider recommendations of the Air Navigation Commission for amendment of the Annexes and take action in accordance with the provisions of Chapter XX;³²

n) Consider any matter relating to the Convention which any contracting State refers to it.”

Thus, the Council has quite explicit and far-ranging powers in the context of the Chicago Convention and ICAO's remit to deal with civil aviation. It can be seen as the main body initiating and pushing through new regulations under the system of the Convention when it comes to air navigation issues, mandated by the Assembly and crucially building on and implementing work done by the ANC.

The ANC itself finally has been given the mandate, under Article 57, to:

“a) Consider, and recommend to the Council for adoption, modifications of the Annexes to this Convention;

30. As referred to *supra*, the ANC in principle was already established by the Chicago Convention itself, notably Arts. 56-57, which comprise Chapter X.

31. See further *infra*, chapter 4.

32. Chapter XX, consisting of Art. 90, deals with the formal adoption and amendment of Annexes (SARP's) to the Chicago Convention, which in deviation from the normal voting procedures call for a two-thirds majority in the Council.

- b) Establish technical subcommissions on which any contracting State may be represented, if it so desires;
- c) Advise the Council concerning the collection and communication to the contracting States of all information which it considers necessary and useful for the advancement of air navigation.”

Thus, as is borne out by the multitude of legal, regulatory and recommendatory actions in the field to be discussed as to substance in the next chapter, the Chicago Convention has endowed ICAO with a wide range of competencies for continuously updating the aviation sector in terms of safety enhancing measures, obviously including satellite navigation.

C. Other Relevant ICAO Competencies under the Chicago Convention

Part I of the Chicago Convention provides for the very general basis of any specific air navigation regulation, fundamentally hinging on the concept of state sovereignty over national airspace. Any competencies for ICAO are to be seen therefore as exceptions to this general rule. Some of those competencies have been developed in the context of ICAO and the capacities given to its main organs. A few others have been spelled out in the Chicago Convention itself and will now be briefly surveyed.

Though strictly speaking not relating to air navigation, ICAO is given the possibility to recommend procedures for dealing with accidents or serious technical defects with substantial international aspects, including such defects in air navigation facilities, by means of inquiries.³³ Such recommendations would be offered to the state where the accident took place, and have in a large number of instances indeed been offered by ICAO. This, however, leaves the sovereignty of an individual state to provide for air navigation facilities in its own airspace in the manner it deems correct, with reference also to Article 28 of the Chicago Convention, basically untouched. To what extent for example state(s) providing GNSS services, as a potential (contributory) cause of an accident, could, would or should be included in such accident investigations, remains yet to be seen – and should be dealt with at some point in the near future.

The most important ICAO competence with a view to air navigation issues is the broad one to adopt international standards and recommended practices under Article 37 of the Convention.³⁴ Specific reference is made here amongst

33. See Art. 26, Chicago Convention.

34. Art. 37, Chicago Convention, provides: “Each contracting State undertakes to collaborate in securing the highest practicable degree of uniformity in regulations, standards, procedures, and organization in relation to aircraft, personnel, airways and auxiliary services in all matters in which such uniformity will facilitate and improve air navigation. To this end the International Civil Aviation Organization shall adopt and amend from time to time, as may be necessary, international standards and recommended practices and procedures (...)”. See further *infra*, chapter 4.

others to such SARP's on communications systems and air navigation aids, including ground marking; rules of the air and air traffic control practices; the licensing of operating and mechanical personnel; the airworthiness of aircraft; the collection and exchange of meteorological information (which is also relevant for air navigation); aeronautical maps and charts; and accident investigation with respect to aircraft in distress and investigation of accidents.³⁵ A safety-net clause moreover provides that SARP's may be issued on any "other matters concerned with the safety (...) of air navigation as may from time to time appear appropriate".³⁶ Any adoption or amendment of SARP's requires a two-thirds majority of the member states represented on the Council.³⁷

The role and competencies of ICAO in this regard also follow from its objectives, as spelled out in Article 44 of the Convention. This mandate include the objectives to:

- "a) Insure the safe and orderly growth of international civil aviation throughout the world;
- b) Encourage the arts of aircraft design and operation for peaceful purposes;
- c) Encourage the development of airways, airports, and air navigation facilities for international civil aviation;
- d) Meet the needs of the peoples of the world for safe, regular, efficient and economical air transport;
- (...)
- g) Avoid discrimination between contracting States;
- h) Promote safety of flight in international air navigation."

A further role of note for ICAO is spelled out in Part III, which deals with "International Air Transport", notably Chapter XV on "Airports and Other Navigation Facilities". The baseline, harking back to the state sovereignty already spelled out by Articles 1 and 28 of the Chicago Convention, is found in Article 68, which provides that each state is entitled to designate any route to be followed within its territory by any international air service.³⁸

Further to this provision, ICAO is given some competencies to try and ensure both that the differences between applicable national regulations and systems are minimised as much as possible, and that the overall level of safety is enhanced as much as possible. Thus, the Council may, if it considers air navigation facilities not to be reasonably adequate for the safe operation of

35. See Art. 37(a), (c), (d), (e), g), (i) and (k), respectively, Chicago Convention.

36. Art. 37, Chicago Convention.

37. See Art. 90, Chicago Convention.

38. Art. 68, Chicago Convention, reads: "Each contracting State may, subject to the provisions of this Convention, designate the route to be followed within its territory by any international air service and the airports which any such service may use".

international air services, consult with the state in question as well as other states affected, and may even make recommendations to remedy the situation.³⁹

ICAO may also financially support a particular state in implementing any such recommendations, or even “provide, man, maintain, and administer any or all of the (...) air navigation facilities including radio and meteorological services, required in its territory for the safe (...) operation of the international air services of the other contracting States, and may specify just and reasonable charges for the use of the facilities provided”.⁴⁰ Further Articles specify some of the details of the arrangements necessary for those purposes, including the possibility for states to take over facilities operated by ICAO under the above clause.⁴¹

States are allowed under the Chicago Convention to pool their air services, including air navigation-related ones, in joint operating organisations for any route or in any region, provided they comply with requirements to register any such agreements with the ICAO Council as well as in accordance with determinations by the Council on application of the Convention’s provisions to such agreements.⁴² The Council may also itself suggest the establishment of such organisations.⁴³ So far, Eurocontrol provides the most manifest example of applying this clause, even though its actual air service provision activities remain rather limited in geographical scope. The concept of the Single European Sky represents another major step forward also from this perspective.

Finally, for completeness’ sake it may be noted that some general provisions of the Chicago Convention may also turn out to have a bearing in the specific field of air navigation, such as the system for the settlement of disputes which is included in the Convention by way of Chapter XVIII (Articles 84-88).

D. Concluding Remarks

The Chicago Convention has clearly endowed ICAO with a number of important competencies to make a difference in the field of aviation safety, including issues of navigation. The roles and competencies of the Assembly and the Council in particular allow ICAO to take the lead in many respects in harmonising national legislation and regulation, which in and of itself is already enhancing the safety of international aviation. In addition, it has allowed ICAO to become and remain a key driving factor in pushing acceptable minimum levels of safety upwards, as an efficient instrument of the general public’s interests in enhanced safety and similar interests of the airline industry in enhancement of both safety and efficiency. Thus, it now remains to be seen to what extent such competencies have actually been used, in terms of substance, for those specific purposes.

39. See Art. 69, Chicago Convention.

40. See Art. 70, resp. Art. 71, Chicago Convention.

41. See Arts. 72-76, esp. Art. 75, Chicago Convention.

42. See Art. 77, Chicago Convention; also Art. 81.

43. See Art. 78, Chicago Convention.

IV. THE ANNEXES TO THE CHICAGO CONVENTION

A. The Role of the Annexes and SARP's

As indicated above, apart from itself containing provisions relative to rights and obligations of the contracting states relevant for air navigation services and allotting to ICAO certain competencies for the same purposes, the Chicago Convention provides for the adoption of international Standards and Recommended Practices (SARP's), contained in Annexes, as a third, flexible means to further the safety of aviation.⁴⁴ The ICAO Council is mandated to adopt such SARP's to facilitate international air transportation and navigation, and to arrive at a globally compatible system.⁴⁵

Whilst Standards in themselves, contrary to often-held opinion (and contrary to Recommended Practices), are binding,⁴⁶ states continue to have the power to implement these Standards within their territory, which under circumstances could still lead to divergences of note. Moreover, states effectively enjoy the choice of an opt-out: they can with reason and upon notification to ICAO deviate from adopted Standards with respect to relevant activities.⁴⁷

As for the communication, navigation and surveillance aspects of air navigation the relevant secondary requirements are spread over a number of the eighteen Annexes to the Convention, which have a high degree of inter-connection. Only the most important Annexes will be treated here; a complete overview would have to take such Annexes as on "Personnel Licensing" (Annex 1), "Airworthiness of Aircraft" (Annex 8) and "Aerodromes" (Annex 14) into account as well.

B. Annex 10: Aeronautical Telecommunications

The use of satellites for navigation purposes, first of all, is intricately intertwined with the more classical concept of telecommunication: it uses radio-waves to transmit messages whose content is important for the users, and in order to achieve a coherent system of air navigation (whether with the help of satellites or not) communication of relevant position and navigation information to a central controlling entity – the Air Traffic Control (ATC) centre – is of key importance. As a consequence, much if not all of the equipment used for satellite navigation purposes could, would or should qualify as telecommunications equipment, and the same goes for relevant procedures and software. Hence, the starting point for allowing the introduction of GNSS in civil aviation for safety and efficiency purposes in a satisfactory manner would be the Annex on aeronautical telecommunications, which is Annex 10.

44. See, again, Art. 37, Chicago Convention.

45. See Art. 54(1), Chicago Convention.

46. Cf. Arts. 37, 38, Chicago Convention.

47. See Art. 38, Chicago Convention.

Annex 10 thus contains the SARP's for certification and operation of facilities and equipment for Communication, Navigation and Surveillance (CNS). Annex 10 is currently comprised of five volumes: Volume I – Radio Navigation Aids; Volume II – Communication Procedures; Volume III – Communications Systems; Volume IV – Surveillance Radar and Collision Avoidance Systems; and Volume V – Aeronautical Radio Frequency Spectrum Utilization.

Volume I deals with equipment and systems (Part I) and radio frequencies (Part II), whilst Volume II deals with aeronautical communications procedures, including Procedures for Air Navigation Services (PANS). Also, Volume II in its Chapter 2 identifies four aeronautical telecommunications services which includes the Aeronautical Radio Navigation Service. Adherence to the Standards contained in these Volumes enables interoperability between ground and airborne equipment, and is of great importance for the providers of air navigation facilities and services as well as for aircraft operators. It should be noted furthermore, that Annex 10 makes reference to the ITU Radio Regulations, which contain crucial provisions for the conduct of any aeronautical communications services.

Chapter 2 of Part I contains a list of standard radio navigation aids. Standard specifications that have been drafted with a view to the usage of Instrument Landing Systems (ILS) and Microwave Landing Systems (MLS) in the approach and landing phases of a flight (the standard non-visual aids) remain minimum standards. Any other system operated should achieve the precision approach categories as defined in Chapter 3. Similar specifications for GNSS-aided Landings Systems (GLS) are being developed, through Amendment No. 77 so far only as far as GPS and GLONASS are concerned (as these are the only full-fledged GNSS systems currently operational).

Implementation of new CNS technology such as satellite navigation of course should be reflected in Standards for all equipment components to be validated, internationally agreed and then laid down in Annex 10. Thus, it is important to note the recent amendments made to accommodate GNSS.

The Amendment fundamental for GNSS concerns No. 76, to the 5th edition of Annex 10, Part I, dating from 1 November 2001. This Amendment stems from the 3rd meeting of the ICAO GNSS Panel and a proposal by the United Kingdom for continuity of service requirements for ILS and MLS. Thus, it established the standards on "General provisions for radio navigational aids",⁴⁸ and the permissibility of terminating a GNSS satellite service with a six-year advance notice by a service provider.

The same applies to the changes made regarding GNSS system requirements which are complemented by Appendix B, presenting the detailed technical specifications for GNSS.⁴⁹ This provision is itself supplemented by information and material for guidance in the application of GNSS SARP's in Appendix D.

48. See para. 2.4, Amendment No. 76 to Annex 10 to the Chicago Convention.

49. See provision 3.7, Annex 10 to the Chicago Convention.

Another important feature provided by Annex 10 concerns the provisions on harmful interference with the use of radio frequencies. Specifications are provided on allowable power emissions and minimum frequency interference levels. In this regard, the ITU Constitution⁵⁰, ITU Convention⁵¹ and Radio Regulations constitute an important instrument against harmful interference.

More recent amendments offered still further elements of regulation targeted at GNSS usage in air transport. Thus, in November 2002 Amendment No. 77 entered into force, which includes a number of relevant dispositions. GLONASS-related technical specifications were included in the sections on Space-Based Augmentation Systems (SBAS) and Ground-Based Augmentation Systems (GBAS) within the requirements regarding GNSS. Provision is further made for use of the GBAS positioning service in support of terminal area navigation. Also, a new type of message to enhance the performance of SBAS has been introduced. Finally, additional guidance material was provided clarifying some of the relevant issues.

November 2004 a further Amendment, No. 79, became applicable, which introduced changes to the GNSS SARP's and associated guidance material concerning performance specifications for Approach with Vertical Guidance (APV); discontinuation of GPS Selective Availability (SA) and clarification of signal power level; specifications for the modernized GLONASS-M system; incorporation of Satellite-Based Augmentation System (SBAS) alert limits in a Cyclic Redundancy Check (CRC); guidance on frequency planning criteria for Ground-Based Augmentation Systems (GBAS); GNSS receiver interference thresholds for pulsed interference; GNSS receiver integrity in the presence of interference; and GBAS broadcast spurious emissions.

Finally, with the latest Amendment of November 2005, No. 80, Volume I of Annex 10 introduces changes to the Strategy for Introduction and Application of Non-Visual Aids to Approach and Landing. The purpose of this amendment is to take account of developments in aeronautical navigation including the evolutionary developments of GNSS, the introduction of GNSS-based operations, and development of Multi-Mode Receivers (MMR's) capable of supporting ILS, MLS and GNSS-based approach operations.

In sum, Annex 10 clearly constitutes one of the most rapidly evolving Annexes when it comes to GNSS, and major and quite detailed steps have already been taken. The incorporation of GNSS into the existing elaborate system for dealing with aviation system at the global level, as far as at least the two primary systems GPS and GLONASS and their various augmentation systems –

50. Constitution of the International Telecommunication Union (ITU Constitution), Geneva, done 22 December 1992, entered into force 1 July 1994; 1825 UNTS 1; UKTS 1996 No. 24; Cm. 2539; ATS 1994 No. 28; Final Acts of the Additional Plenipotentiary Conference, Geneva, 1992 (1993), at 1; it was substantially amended twice since 1992.

51. Convention of the International Telecommunication Union (ITU Convention), Geneva, done 22 December 1992, entered into force 1 July 1994; 1825 UNTS 1; UKTS 1996 No. 24; Cm. 2539; ATS 1994 No. 28; Final Acts of the Additional Plenipotentiary Conference, Geneva, 1992 (1993), at 71; it was substantially amended twice since 1992.

including the European EGNOS⁵² – are concerned, is thus well on its way.

C. Annex 11: Air Traffic Services

Next to GNSS as part of the concept of (aeronautical) telecommunications, its potential role in Air Traffic Control as part of the broader concept of Air Traffic Services (ATS) is to be noted. Amongst the SARP's, it is Annex 11 which deals with those issues and will therefore be looked at here to scrutinise to what extent developments regarding GNSS have already begun to be taken into account.

The provisions of Annex 11 define the services and contain the Standards to be applied by state and private ATS providers. The edition of Annex 11 which dated from July 1994 did not yet reflect satellite navigation technology and services to any appreciable extent. However, some provisions did already have relevance to air navigation services in general, and as such would also apply to GNSS services.

A state may for example delegate, by mutual agreement, to another state the responsibility for establishing and providing air traffic services in Flight Information Regions (FIR's), control areas or control zones extending over its own territories.⁵³ Although the providing state's responsibility is limited to technical and operational considerations, this is a further elaboration of the 'overflow' zone concept referred to earlier. Furthermore, it is of particular importance to reiterate the existence of relevant arrangements for the provision of ATS in those portions of airspace over the high seas or in airspace of undetermined sovereignty.⁵⁴ Under provision 2.1.3, once it has been determined that air traffic services will be provided, the states concerned shall designate the authority responsible for providing such services. Such an authority may be either a state or a suitable (non-state) agency.

Chapter 1 defines air traffic service as "a generic term meaning variously, flight information, alerting service, air traffic advisory service, air traffic control service (area control service, approach control service or aerodrome control service)". Further to this, three different kinds of air traffic services are identified:⁵⁵

- air traffic control services, divided into area control services, approach control services and aerodrome control services;

52. EGNOS, the European Geo-Stationary Navigation Overlay System, is a tripartite cooperation effort between the European union as represented by the European Commission, the European Space Agency (ESA) and Eurocontrol, the European air navigation organisation. Legally speaking, it was based on the Agreement between the European Community, the European Space Agency (ESA) and the European Organisation for the Safety of Air Navigation on a European Contribution to the Development of a Global Navigation Satellite System (GNSS), Luxembourg, done 18 June 1998, entered into force 18 June 1998; OJ L 194/16 (1998).

53. See provision 2.1.1, Annex 11 to the Chicago Convention.

54. See provision 2.1.2, Annex 11 to the Chicago Convention.

55. See provision 2.3, Annex 11 to the Chicago Convention.

- flight information services; and
- alerting services.

Air Traffic Control (ATC) services are defined here as services provided for the purpose of preventing collision between aircraft and dealing with the manoeuvring area between aircraft and obstructions, as well as expediting and maintaining an orderly flow of air traffic. Required Navigation Performance (RNP) types shall be described for the purpose by states, which shall be done on the basis of regional air navigation agreements,⁵⁶ whilst the prescribed RNP type should be appropriate with respect to the level of communications, navigation and air traffic services provided in the airspace concerned.⁵⁷

It should be kept in mind that, as far as GNSS would be involved, the aforementioned provisions relate to the state or the agency which performs the role of an air traffic service provider, and thus acts as an intermediate between the aircraft operator (the user) and the provider in first instance of the GNSS signal or service (the satellite system operator). As for any direct link between the aircraft operator and the satellite system operator, a proper legal framework to deal therewith specifically is yet to be established.

Within the framework of ICAO, the next step from the present perspective concerned the development of SARP's on the use of GNSS signals as a means of positioning, in other words as navigation aids. These developments have resulted in the last issue of Annex 11 which is the 20th edition, dating from July 2001; as from 1 November 2001 it superseded all previous editions. It incorporates Amendment No. 40 to include several provisions, such as the flexible use of airspace, equipment in ATS units, and suchlike.

Annex 11, dealing with airspace, units and services as necessary for the promotion of the safe, orderly and expeditious flow of air traffic, also establishes the requirements for communication and information. In this context, the Annex refers to information on the operational status of air navigation aids, referring in turn to Annex 10 in the case of non-visual aids.⁵⁸ What is lacking at the moment in Annex 11 is a reference to material relating to a method of establishing ATS routes defined by GNSS, but this seems more an operational issue that will be addressed whenever the need arises. When GNSS will be available for general use at the required levels of accuracy⁵⁹, availability⁶⁰ and

56. See provision 2.7.1, Annex 11 to the Chicago Convention.

57. See provision 2.7.3, Annex 11 to the Chicago Convention.

58. See provision 7.3.1, Annex 11 to the Chicago Convention.

59. 'Accuracy' is defined in the GNSS context as "the degree of conformance between the estimated or measured position and/or velocity and the true position and/or velocity of the user at a given level of confidence at any given instant time and at any location in the coverage area"; GALILEO Mission High Level Definition, of 23 September 2002, p. 64.

60. 'Availability' with regard to GNSS services is defined as "the portion of time that a system can be used for its intended (...) purpose"; GALILEO Mission Requirements Document, Issue 5, Rev. 1.1, of 27 March 2003, p. 84.

integrity⁶¹, surely the efforts of standardising the establishment of ATS routes will be felt.

As of November 2005, Amendment No. 43 is applicable, which actually comprised four main changes, respectively:

- concerning the revision of provisions relevant to air traffic services;
- concerning altitude-keeping requirements and altitude-monitoring requirements associated with reduced vertical separation of aircraft;
- an editorial amendment concerning ATS safety management; and
- an amendment concerning electronic terrain and obstacle data.

Annex 11 does not yet refer specifically to the use of GNSS signals, however, for such purposes. In respect of this Annex, in other words, a lot more needs to be done to ensure optimum introduction of GNSS for the purpose of safety and efficiency taking into account its specific characteristics.

D. Annex 2: Rules of the Air

The rules developed in Annex 2 contain general rules, visual flight rules and instrument flight rules, and thus implement Article 12 of the Chicago Convention.⁶² The foreword to this Annex provides *inter alia*: “the Annex constitutes the Rules relating to the flight and manoeuvre of aircraft within the meaning of Article 12”. These apply without exception over the high seas, as well as over national territories to the extent that they do not conflict with the rules of the state being overflown. When operating under air traffic control, aircraft must maintain the route and the altitude assigned to it. Also, it must keep air traffic control informed about its position.

The applicability of Annex 2 to the airspace over the high seas without exception is reiterated in Chapter 2.1.1, and confirmed in Chapter 2.1.2. Annex 2 is thus important for the current issue, since it reiterates and elaborates the competence for ICAO to charge certain states with the provision of air navigation services over FIR's outside their own airspace. In doing so, it

61. ‘Integrity’ in the GNSS context should be defined as “the probability, in any TBD period, at any location in the coverage area, that the position error does not exceed the alarm limit without an alarm being provided to the user within the time to alarm”, thus effectively indicating a measure of trustworthiness; GALILEO Mission Requirements Document, Issue 5, Rev. 1.1, of 27 March 2003, p. 82.

62. Art. 12, Chicago Convention, reads: “Each contracting State undertakes to adopt measures to insure that every aircraft flying over or manoeuvring within its territory and that every aircraft carrying its nationality mark, wherever such aircraft may be, shall comply with the rules and regulations relating to the flight and manoeuvre of aircraft there in force. Each contracting State undertakes to keep its own regulations in these respects uniform, to the greatest possible extent, with those established from time to time under this Convention. Over the high seas, the rules in force shall be those established under this Convention. Each contracting State undertakes to insure the prosecution of all persons violating the regulations applicable”.

obviously departs from the baseline situation of territorial application of the rules of the air in accordance with provision 2.1.2 of Annex 11, as indicated before.

Relevant is also the provision dealing with communications.⁶³ Aircraft may be deemed to operate in a 'controlled flight' mode. In such a case, it shall maintain continuous listening watch on the appropriate radio frequency of, and establish two-way communications as necessary with, the appropriate air traffic control unit. The appropriate Air Traffic Services (ATS) authority in respect of aircraft forming part of aerodrome traffic at a controlled aerodrome may prescribe exceptions.⁶⁴ 'Air traffic control unit' in this context is a generic term meaning variously 'area control centre', 'approach control office' or 'aerodrome control tower'.

Provision 3.6.5.2 then provides for rules in case of communication failure. In this regard, Chapter 5 on Instrument Flight Rules (IFR) stipulates that an IFR flight operating outside controlled airspace, but within or into areas or along routes designated by the appropriate ATS authority in accordance with provisions 3.3.1.2 (c) or (d), shall maintain a listening watch on the appropriate radio frequency and establish two-way communications.⁶⁵ This, as necessary, with the air traffic services unit providing flight information services.

With the appearance of GNSS on the scene, with regard to Annex 2 some first steps have indeed been taken. The version of this Annex dating from 1 November 2001 (Amendment No. 36 to the 9th edition of July 1990), superseded some of the dispositions with more up-to-date ones. Amendment No. 36 is of special importance since it does revise some fundamental definitions as those of 'air traffic control unit', 'approach control unit', 'alternate aerodrome', 'flight crew member', 'pilot-in-command', and 'visibility', the most of which are relevant for GNSS systems and any entities involved in their operations and activities.

The provisions relating to this issue were introduced in Annex 2 and the Procedures for Air Navigation in terms of Air Traffic Management (PANS-ATM) in 1997, to require an aircraft experiencing communications failure to climb to its filed flight plan level after a specified period of time, in order for the aircraft to be able to reach its destination without experiencing fuel starvation. Although these new provisions were considered to be an improvement, it was felt in Europe that, in an environment where radar was used in the provision of ATS, the required time for an aircraft with communications failure to maintain its present level after passing a compulsory reporting point should be reduced. Therefore, Regional Supplementary Procedures were developed and approved which are now included in the European Regional Supplementary Procedures. These procedures require the aircraft to climb seven minutes after experiencing communications failure, provided that certain conditions are fulfilled.

63. Provision 3.6.5, Annex 2 to the Chicago Convention.

64. See provision 3.6.5.1, Annex 2 to the Chicago Convention.

65. See provision 5.3.2, Annex 2 to the Chicago Convention.

The ICAO Secretariat was of the opinion that these procedures could be used in radar environments on a global basis, and proposals for amendments to Annex 2 and the PANS-ATM were presented. Proposals were also made to allow other possible means of communications to be used when communications failure is being experienced. Additionally, it has become apparent that when an aircraft on an IFR flight plan experiences communications failure, it is not always appropriate for it to land at the nearest suitable aerodrome as currently prescribed in the PANS-ATM. Therefore, proposals are made to take into account the likelihood that the aircraft will continue on its flight plan. Following adoption of the amendments to Annex 2 and the PANS-ATM, Regional Supplementary Plans are deleted – signifying that the global reach of GNSS and the possibilities for arriving at a globally seamless system offered by its proper introduction are now being accepted in principle.

Developments have not stopped there, however. The latest Amendment to this Annex, No. 38, included global and regional procedures concerning communication failure procedures, taking advantage of new technologies and current knowledge in the application of communications failure procedures. Securing the highest practical degree of harmonisation will facilitate and improve the safety of air navigation. Thus, Annex 2 is also in a process of continuous updating and adapting to some very specific aspects of GNSS, even if often only indirectly so.

E. Annex 6: Operation of Aircraft

Annex 6 on the operation of aircraft – after all the main direct target of positioning and navigation information, whether derived from GNSS or otherwise – also contains provisions directly affecting certain aspects of air navigation. Part I (International Commercial Air Transport-Aeroplanes, 8th edition, November 2001, incorporating all of twenty-six Amendments), dealing with international commercial air transport, states that all aeroplanes on all flights should be equipped with adequate instruments for operation.⁶⁶ Chapter 7 of Part I elaborates on the provision of adequate equipment for communication and navigation, as well as the installation thereof.⁶⁷

Communication equipment should be capable:

- of handling two-way communications for aerodrome control purposes;
- of receiving meteorological information at any time during flight; and
- of handling two-way communications at any time during flight with at least one aeronautical station and with such other aeronautical stations (and on such frequencies) as may be prescribed by the appropriate authority.

66. See provision 6.2.1, Annex 6 to the Chicago Convention.

67. See, respectively, provisions 7.1, 7.2 and 7.3, Annex 6 to the Chicago Convention.

Such equipment moreover shall provide for communications on the aeronautical emergence frequency 121.5 MHz.⁶⁸ In accordance with provision 7.2.1, furthermore, navigation equipment under the November 2001-situation should allow aircraft carrying it “to proceed:

- in accordance with the operational flight plan;
- in accordance with prescribed RNP types; and
- in accordance with the requirements of air traffic services, except for navigation under visual flight rules, if this is not precluded by the appropriate authority.”

With the adoption of a new Amendment No. 23, however, the requirement referring to prescribed RNP types has been separated from the main clause, and the relevant provision 7.2.1 now reads that aircraft should be allowed “to proceed:

- in accordance with the operational flight plan; and
- in accordance with the requirements of air traffic services, except for navigation under visual flight rules, if this is not precluded by the appropriate authority.”

This may be seen as a very fundamental first step to allowing, in principle, the implementation of ‘free flight’ or ‘free routing’ concepts as one of the main benefits future GNSS may bring. Now, a new and separate provision 7.2.2 deals with cases of airspaces or routes where an RNP type remains prescribed, providing that in addition to the requirements under provision 7.2.1 aircraft should be provided with navigation equipment which will enable it to operate in accordance with the prescribed RNP type(s); and be authorised by the state of the operator for operations in such airspace.

In case of a Regional Air Navigation Agreement, the minimum navigation performance specifications and procedures are published in the Regional Supplementary Procedures.⁶⁹ Provision 7.2.3 stipulates the requirement of adequate equipment, when a vertical separation minimum of 300 m is applied above flight level (FL) 290. It may be noted that for the airspace of forty-one European and North-African states as of early 2002 the minimum vertical separation above FL 290 has been halved, thus adding another six FL’s, under the supervision of, and based upon a safety-case analysis by, Eurocontrol.

Part II of Annex 6 (International General Aviation-Aeroplanes, 6th edition, November 1998) includes provisions for aeroplanes for international general aviation. Currently, Amendment No. 24 is applicable – as of November 2005.

The aforementioned rules do not mention specifically air navigation or traffic services, or equipment to be used within satellite navigation systems. However, as far as navigation equipment is concerned, provision 7.2.1(c) states that

68. See provision 7.1.2, Annex 6 to the Chicago Convention.

69. See provision 7.2.2, Annex 6 to the Chicago Convention.

equipment should be able to proceed in accordance with the requirements of air traffic services, which appears to offer some room for inclusion of such specific equipment when satellite navigation services will become a matter of everyday practice. With the latest Amendment No. 29 of Part 1 of Annex 6, new standards were laid down concerning operator management of electronic navigation data products.⁷⁰

F. Concluding Remarks

Though to a varying degree, a fundamental effort is under way in the various Annexes to accommodate proper introduction of GNSS into civil aviation – often moreover in considerable detail. At the same time, the advent of GNSS on the scene – and in particular the high-accuracy, integrity-monitored services Galileo is expected to bring⁷¹ – is of such a fundamental and sweeping nature, that broader issues are at stake than only the more technical and operational ones that SARP's are able to cope with. As a consequence, the discussions within ICAO have also spawned some other interesting (legal) documents on the issue, which will be briefly surveyed at this point.

V. OTHER IMPORTANT LEGAL DOCUMENTS DRAFTED WITHIN THE ICAO CONTEXT

A. The Global Plan for CNS/ATM Systems and the Issue of a GNSS Convention

Not an Annex to the Chicago Convention as such, the next document of importance for GNSS and Galileo thus concerns the Global Air Navigation Plan for CNS/ATM Systems. The second edition of this document, based on the known shortcomings of conventional systems and the analyses of the FANS Committee, already pointed *inter alia* to the benefits of implementing and using a global air navigation structure.

The third edition of the now-renamed Global Plan is based on Recommendations from the 11th Air Navigation Conference. Objective of the third edition is to ensure that maximum advantage be taken of presently-available aircraft capabilities in the near and medium terms. Over the longer term, transition strategies being developed on the basis of the Global ATM Operational Concept are to be incorporated in the Global Plan.

An Industry Roadmap further addresses short- and medium-term implementation activities associated with CNS/ATM systems, while the longer-

70. See provisions 7.4.1 and 7.4.2, Annex 6 to the Chicago Convention.

71. In particular 'integrity monitoring' is of major importance for aviation. Following from the definition of 'integrity' as provided *note* 61, 'integrity monitoring' refers to the principle of checking whether the relevant instruments can, indeed, be trusted, and ensuring that if not, the user – in this case the pilot – is immediately alerted to this fact.

term objectives are addressed in the operational concept. The Roadmap, if implemented successfully, would lead to convergence with the ATM system envisaged by the operational concept and, together with the Global Plan and operational concept, forms a comprehensive planning structure.

Relevant legal issues are (to be) addressed by the Panel of Legal and Technical Experts (LTEP). Also, the text of the Charter of the Rights and Obligations of States relating to GNSS, approved at the 32nd ICAO Assembly is included.⁷² This document establishes some of the boundary conditions to the legal issues in aviation in their broadest implications possible, as understood by the civil aviation community.

A particularly thorny political issue in this context concerns the concept of an overarching 'GNSS Convention', which should include some obligations on the part of the providers of GNSS – currently the relevant US and Russian authorities – with respect to such service provision, including notably a fundamental acceptance of liability in cases where wrongful or absent GNSS signals would contribute to accidents or incidents.⁷³ Whilst the two current GNSS providers have no interest in taking such legal obligations upon their shoulders for the provision of what is, in essence, a free service, most other states would feel considerably more comfortable accepting GNSS as an indispensable part of air navigation *with* such legal commitments in place. After all, their ultimate responsibility under Article 28 of the Chicago Convention for safety within their national airspaces would remain intact, regardless of whether part of their air navigation infrastructure (the GNSS satellites) is fundamentally outside their control and jurisdiction.

It is rather illustrative to note here the conclusions drawn with respect to a report of the legal commission at the 35th ICAO Assembly on the establishment of a legal framework with regard to CNS/ATM systems including GNSS, as drawn and presented on the one hand by the United States:

“6. Conclusions

6.1 It is time for ICAO to stop seeking a new “long-term legal framework” for which there is no prospect for consensus and instead concentrate on practical measures to bring CNS/ATM into reality.

6.2 ICAO should adopt a resolution that takes credit for the positive work done during the extended quest for a long-term legal framework and that calls for renewed commitment by ICAO to developing the practical tools for implementation.

6.3 The resolution should also suspend work on legal proposals that have been unable to gain consensus while leaving open the possibility of

72. Legal Issues, Appendix to Chapter 11. On the Charter, see further *infra*, section 5.3.

73. See on the issue of the extent of current US acceptance of liability e.g. the author's Liability for Global Navigation Satellite Services: A Comparative Analysis of GPS and Galileo, *Journal of Space Law*, vol. 30 (2004), pp. 140-3.

renewing legal and institutional work if, and only if, actual barriers are identified by the technical officials doing the real-world implementation work.”

By contrast, the conclusion drawn and presented by forty-one other ICAO member states shows quite another approach:

“6.1 As indicated above, strong support has been consistently expressed by those who consider that the status quo does not provide sufficient answers to the legal and institutional aspects of the GNSS system within a new CNS service. Most importantly, the vast majority of States, other GNSS providers and users of GNSS services will require legal certainty as to who is responsible for any particular aspect of the system and what the eventual liability and burden of proof will be. The elaboration of a convention does not detract in any way from the benefits of a contractual framework as an interim solution. An efficient interim arrangement that addresses all the major issues would adequately compensate for the fact that a convention would be some years off. Indeed, an effective and readily available contractual framework, which harmonises contractual relationships between the parties involved in GNSS implementation, while being responsive to the evolution of the satellite-based CNS/ATM system, could ease the way for a convention and promote its faster adoption.”

In short, it seems there is no likelihood anytime soon on a global agreement that includes the United States on an overarching regime for GNSS-usage in the aviation context. Thus, the above discussion mainly serves as a major stimulus for Galileo to offer its own tailor-made solution for the aviation context, by accepting a coherent set of binding two-way legal arrangements to those states, air service providers and users interested in such a regime.

**B. Procedures for Air Navigation Services (PANS),
Regional Supplementary Procedures (SUPP's)
and Regional Air Navigation Plans (RANP's)**

Also outside of SARP's, regulation related to air navigation can be – and is – adopted by ICAO, although the Chicago Convention does not make specific provision for those. This concerns the detailed operating practices provisions laid down in the Procedures for Air Navigation Services (PANS) as well as Regional Supplementary Procedures (SUPP's).

To qualify as PANS, the procedure shall be agreed as suitable on a worldwide basis, and is approved by the Council for world-wide application. PANS contain, for the most part, operating procedures regarded as not yet having attained a sufficient degree of maturity for adoption as SARP's, as well as material of a more permanent character which is considered too detailed for incorporation in an Annex, or is susceptible to frequent amendment, for which the processes of the Chicago Convention would be too cumbersome.

SUPP's are operational procedures and material of the character of PANS but designed to be specifically applied in one of the ICAO air navigation regions only. They have a status similar to that of PANS also in that they are approved by the Council, but only of course for application in the respective regions. Certain of the procedures apply to overlapping regions or are common to two or more regions.

Regional Air Navigation Plans (RANP's) finally are established for nine geographical regions, and define in each region relevant requirements for international air navigation. In the context of ensuring global compatibility air navigation planning is also conducted on a regional basis (as opposed to a national one). The legal status of the RANP is that of an authoritative reference document internationally agreed upon and approved by the ICAO Council.

The principal point with a view to GNSS is that its global scope and potential for globally seamless navigation procedures and infrastructures would seem to call for as limited a usage of in particular SUPP's and RANP's in this context as possible, since these would threaten to interfere by their very nature with any global consistency.

C. The Broader Picture: The GNSS Charter

Since a number of years now ICAO has been undertaking substantial efforts to establish a legal framework for GNSS-usage in aviation. A major milestone in this respect constituted the formal endorsement and adoption of the Charter on the Rights and Obligations of States Relating to GNSS Services at the thirty second session of its Assembly in Montreal (September-October 1998).⁷⁴

As the Charter is essentially the beginning, it contains broad and general principles rather than specific and focused guidelines or rules. Many of those have already started to become a reality by means of the Annexes as discussed above. Nevertheless, the Charter as the basic first step towards a concentrated effort at rule-making into the new area of GNSS at a global level will continue to serve as the general framework within which SARP's and other regulatory measures will have to fit. For example, it is closely related to the work still being undertaken by ICAO's LTEP, and the Global Air Navigation Plan for CNS/ATM Systems mentioned above. Hence it is useful to summarise it here as a background to any regime to be developed in the ICAO context.

The Charter, denoted as a document embodying principles of fundamental importance, contains a number of basic principles applicable to the implementation and operation of GNSS. Some of these principles were derived from the ICAO Council Statement of 1994 and the exchange of letters of ICAO with the United States and the Russian Federation. Others were derived from the recommendations of the 29th Legal Committee, and a third set originated from the Chicago Convention and other rules of international law.

74. See Assembly Resolution A32-19.

By means of the first principle of the Charter states recognise the provision and use of GNSS signals and services as a paramount option for the safety of international civil aviation. The second principle stipulates that every state, respectively aircraft of every state, shall have access, on a non-discriminatory basis and under uniform conditions, to the use of GNSS signals and services, including regional augmentation systems for aeronautical use, within the area of coverage of such system.

Closely related to the issue of non-discriminatory access is the principle of continuity of services. This aspect is connected with the obligation for states providing services to ensure availability, integrity, accuracy and reliability when providing such services. This includes effective arrangements to maintain full operability of the system, to ensure the required system performance level, to minimise the operational impact of system malfunctions or system failure and to achieve expeditious system recovery.

States providing signals and/or services shall ensure that these are in accordance with applicable ICAO Standards. They shall also provide aeronautical information services on any modification of the GNSS signals or services that may affect the provision of the services in due time.

The Charter bases itself upon the principle that every state preserves the responsibility to control the operation of aircraft and to enforce safety and other regulations within its sovereign airspace as following from Article 28 of the Chicago Convention. Emanating from this principle, it is affirmed that the implementation and operation of GNSS shall neither infringe nor impose restrictions upon state sovereignty, authority or responsibility in the control of air navigation and the promulgation and enforcement of safety regulations. Such state authority will also include the coordination and control of communications, and the augmentation of GNSS signals.

At the same time, another principle provides that states shall cooperate to secure the highest practicable degree of uniformity in the provision and operation of GNSS signals and related services. Moreover, states ensure that regional and sub-regional arrangements are compatible with the principles and rules set out in the Charter and with the global planning and implementation process for GNSS. Such a principle of cooperation and mutual assistance must facilitate the global planning and implementation of GNSS whether on bilateral or multilateral basis.

The general principle of due regard for the interests of other states is finally followed by the provision that nothing in the Charter shall prevent two or more states from jointly providing GNSS signals or related services. Thus, any effort to establish Galileo as an international infrastructure under international control is principally in conformity with the Charter, and in many respects (such as referred to above) moreover rather conducive to further development of the Charter's principles.

The Charter is definitely an important step in the formulation of rights and obligations of states in relation to GNSS signals and services. Still, it does not regulate a number of issues, which will come to the fore also when the definition

and institutional characteristics of Galileo and its signals and services will become clear. And, of course, as such the Charter is not binding. At best, it may point the way forward to establishment of any future convention to be concluded, and/or of itself over time, by means of consistent and repeated *de facto* acceptance by states as determining their freedom of action, may acquire the status of international customary law.

VI. FINAL REMARKS

It may be noted that aviation, by its nature in legal and regulatory terms both a very internationalised (i.e. internationally harmonised) and a very safety-oriented sector, is particularly amenable to the benefits GNSS can bring. Thus, the existing legal framework under general international air law applicable to air navigation services will not obstruct the incorporation of GNSS in the operation of such services; on the contrary, it is already adapting to maximise its benefits. In particular in the context of current discussions in ICAO the closest thing to a show-stopper here is the resistance against taking a major legal step forward, i.e. building a comprehensive and fair two-way legal regime for the usage of GNSS in the aviation context that will finally introduce the legal certainty lacking so far.

The Charter does provide the substance – such as respect for sovereignty and principles of international cooperation – but not (yet) the legally binding character which may be necessary to finally convince many states and much of the general public to accept GNSS-based solutions on a global and comprehensive basis. The respect for sovereignty cannot be better brought out by a Convention to which individual states will choose to adhere, and any international cooperation which is to go beyond technicalities or procedures is best codified in such a Convention.

It is clear that GNSS, with its ultimate aim of – as far as aviation is concerned – offering global seamless navigation of aircraft, poses a new set of challenges to the current legal and institutional system. For international lawyers it is interesting to note that this addresses in particular the traditional, sovereignty-based ways in which aviation safety and air navigation has been handled so far, in spite of considerable harmonisation at the international level ever since the Chicago Convention entered into force, and the role of ICAO in those respects started to develop.

A major example thereof concerns Article 28 of the Chicago Convention, matching sovereign control over national airspace with responsibility for the safety of navigation in that airspace. While the current system does offer some flexibilities (Article 22, the possibility for regional systems), and the technical and procedural details can be, and indeed are being worked out in the SARP's, it seems that the challenges GNSS poses may require a more fundamental approach.

Implementation of the revolutionary possibilities offered by ‘free flight’ and ‘free routing’ concepts, which can become a reality thanks to GNSS, should be matched once more by something as comprehensive as a GNSS Convention. In spite of the aforementioned resistance, it would be very appropriate and timely to adapt the international framework in this field as soon as comprehensive yet workable technical standards and procedures have been devised, in order to arrive at harmonisation on a global level. While a lot of progress has been made in particular in the context of the Annexes, much therefore obviously remains to be done.

While a GNSS Convention may not be politically feasible in the short run, the alternative option is the one aimed for by Galileo: offering some services of sufficient quality (accuracy, availability, integrity) against payment, but then (unilaterally respectively through contracts) also offering service guarantees and an appropriate measure of acceptance of liabilities. This concerns the Safety-Of-Life Services (SOL) currently envisaged by Galileo: it will, likely indirectly through current ATC charges, be provided against fees, and will be fully augmented.⁷⁵ This will include above all the level of integrity monitoring required by the aviation sector, as the SOL-concept has basically been developed on the basis of the requirements for air navigation services. Thus, somehow contractual arrangements will underpin this service provision too, including service guarantees and liability reimbursement obligations in appropriate cases.

The result will likely be enhanced usage of GNSS in aviation at least where Galileo will be involved, hence enhanced safety and efficiency of that particular global transport sector. In turn, this also means GNSS will clearly start to live up to its promise to mankind as a whole, honouring the fundamental obligation of Article I of the Outer Space Treaty that “the (...) use of outer space” shall be “for the benefit and in the interests of all countries, irrespective of their degree of economic or scientific development”.

75. “Augmentation” systems should be defined as “regional or local mechanisms such as the European Geostationary Navigation Overlay System (EGNOS) (...). They provide the users of satellite-based navigation and timing signals with input information, extra to that derived from the main constellation(s) in use, and additional range/pseudo-range inputs or corrections to, or enhancement of, existing pseudo-range inputs. These mechanisms enable users to obtain enhanced performance”; Art. 2(a), Cooperation Agreement on a Civil Global Navigation Satellite System (GNSS) – Galileo between the European Community and its Member States and the People’s Republic of China (hereafter EC-PRC Cooperation Agreement), of 30 October 2003; Doc. Council of the European Union, 13324/03. In particular integrity monitoring is a key feature of such augmentation, as the example of EGNOS makes clear; cf. Communication from the Commission to the European Parliament and the Council – Integration of the EGNOS programme in the Galileo programme, COM(2003) 123 final, of 19 March 2003, esp. pp. 2, 4, 7.